STRATEGIC USES OF BORON COMPOUNDS FOR ROCKET AND MISSILE PROPELLANTS

I. Summary and Conclusions

Boron compounds are significant to the manufacture of many important industrial and consumer end items and numerous military use items, none of which, individually, consumes large amounts. On the other hand, when used as a propellant chiefly for rockets and missiles, very large amounts of boron are required under full operating conditions, particularly in case of war. Owing to the efficiency and handling characteristics of boron compounds, substitute materials would be inferior for use in propellants.

The strategic significance of boron compounds derives from the anticipation of very large wartime requirements in the United States and the possibility of similarly large requirements in the USSR.

The apparent shortage of boron compounds in the satellites, chiefly East Germany and Communist China, has resulted in devious and persistent procurement efforts in the free world. So far as is known, all satellite imports come from the free world. At the present time, it is not possible to determine reliably the reason for the failure of the USSR to supply satellite needs from its own resources.

II. Research and Development of Boron Propellants

A. Russian Projects

Russian research on the use of boron hydrides for rocket fuels is known to have been conducted, for example, in the Laboratory of Peroxidic Compounds, Academy of Sciences, Moscow, as early as 1951. German scientists employed in the development of rocket propulsion at the Novy-stroy Aircraft Plant, Podberezye near Ivankovo (Kalinin Oblast) reportedly were asked in 1949 to conduct basic work on this subject. Their work was to include, specifically, the preparation of tetraborane from magnesium boride. Development of the new propellants was coordinated between the Academy of Sciences and the Ministry of Aviation Industry.

B. United States Projects

In the United States, "Project ZIP"[1] for the development of boron propellants, has been in operation since 1952. It has progressed from the laboratory to the pilot-plant stage. The present output is utilized chiefly for engine development. The United States Government is now negotiating for a small production plant, with large-scale production to follow. The utilization of boron propellants now appears assured for certain applications.

To date, Project ZIP has consumed 2,000 tons of boron ore. Until engine research and development work are fully completed, the exact requirements for boron cannot be accurately given. However, since boron propellants are expected to replace, in part, conventional jet fuels, requirements in wartime are expected to be very large, definitely exceeding current US output of borax for all purposes (about 800,000 metric tons).

In the production of boron propellants in the United States, principal commodity inputs consist of boron, hydrogen and carbon as major ingredients; electricity, coal, coke or gas for power; and lithium, sodium and chlorine as chemicals used in processing.

The greater the boron content of the ore, the cheaper the fuel that can be produced. Most of the boron available in the USSR must be obtained from relatively low-grade ore.

Sodium boron ores are more easily converted to propellants than other boron ores. Borax, a sodium borate, is the chief source of boron both in the United States and the USSR.

C. Other Free World Projects

No other free-world countries are known to be conducting research on boron propellants, although a report on boron propellants was published in the UK in 1945.

[1] Coordinator for "Project ZIP" is Navy, Bu/Aer.

III. Supplies, Procurement and Use Patterns of Borax in the Sino-Soviet Bloc

A. Deposits and Production in the Sino-Soviet Bloc

Principal borax deposits in the Sino-Soviet Bloc are located in the USSR, although there are known to be some in Communist China. Reserves of unmined borax available in the USSR as of 1938 are shown in Table I.

Table I

USSR RESERVES OF UNMINED BORAX

(1938 estimate)[2]

Good grade ores:		A*	263,700 Metric Tons
		B	341,700 Metric Tons
		C	138,300 Metric Tons
	Total		743,700 Metric Tons
Low grade ores:		A	1,417,300 Metric Tons
		B	112,000 Metric Tons
		C	5,244,900 Metric Tons
	Total		6,774,200 Metric Tons
	GRAND TOTAL		7,517,900 Metric Tons

*Unmined reserves are classified by the USSR as:
A - Thoroughly explored reserves ready for mining.
B - Reserves geologically explored and defined by tests, with preliminary examinations computed on composition and characteristics of material.
C - Reserves established by geological investigations based on natural or artifically induced appearance of the material on the surface.

[2] Geologicheskaya Issuchennost Mineral' No-syr' Yevava Baza USSR XVIII S'yezdu VKP (b)/Geological Study of Mineral Raw Material Sources of the USSR for the XVIII Congress of the VPK (b)/Moscow-Leningrad 1939.

Assuming an annual rate of production of 25,000 tons for the period 1938-1948[3], and a subsequent growth from this level parallel to that of the Gross National Product, the total production for the period 1938-1955 would be around 550,000 tons, leaving unmined reserves from the above listing of almost 7 million tons. This compares with reserves in the United States currently estimated at several hundred million tons.

The major deposits of the USSR are in the vicinity of Inder Lake at Inderborskiy (48°31' N - 51°47' E) and at many points along the north shore of the Caspian Sea. Good highway and railway transportation is available from these deposits. Other deposits are located in the Mineralnovod-Cheskiy Rayon in the North Caucasus and the Azov-Black Sea area. Although of lower grade, these deposits are being worked, and are also favorably situated for transportation facilities.

As in the United States, the mining of borax in the USSR consists of open pit or surface operations. Recovery of the borax from its ore is a simple matter of dissolving in water and recrystallizing refined borax. Equipment for mining and processing is simple and inexpensive. A very large expansion of capacity could be accomplished easily and quickly without any bottlenecks or limitations due to technological difficulties or shortage of special equipment.

Definite information on Chinese reserves of borax are not available. Several recent reports have been received which include information on the recovery of borax from long-established salt brine wells[4] and the beginning of construction on a borax plant at Tsu-Kung, Szechwan Province[5]. Transportation facilities linking these areas with other parts of China appear to be adequate.

STATSPEC

[redacted]

[3] Based on estimated production of 22,000 metric tons in 1938 in Demitri B. Shimkin, Minerals - A Key to Soviet Power (Cambridge, Mass.,1953),p.253

[redacted]

[5] FDD Summary No. 221, Weekly Economic Information Report on China No. 14 (22 September 1954), Confidential.

B. Imports from Free-World Sources

Preliminary estimates indicate that Sino-Soviet bloc imports of borax and related products from free-world sources have increased from about 5,000 metric tons in 1950 to 8,500 in 1952 and to at least 15,000 in 1954.[6] Current intelligence includes many references to possible diversions to the Bloc of US-origin borax; total free-world shipments of borax to the Bloc may be considerably greater in 1955 than in 1954.

C. Use Patterns

Little is known of use patterns for borax in the Sino-Soviet Bloc. However, total use of borax for non-military purposes in the USSR may be less than 10 percent of corresponding US consumption, which is about half a million metric tons.

In East Germany, 1955 requirements have been estimated at 4,000 tons. However, only 3,000 tons have been planned for import, and East Germany is not known to have any indigenous resources. Even in the face of reports early in 1955 that borax "continues" to be a chief bottleneck in supplies for the East German chemical industry, the planners have, to date made no provision to meet fully the estimated needs. East German imports of borax in 1954 were 1000 tons less than was required and planned, with the result that 1000 tons had to be released from "State Reserves" at the end of November. As of 11 January 1955, only 30 tons had been returned to these Reserves.

These use-pattern indications do not take into account the possibility that the Bloc may be developing boron propellants for military use.

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[6] See "Indications of Soviet Bloc Vulnerability to Controls of West-East Movement of Boron Compounds." IMG/ID-15 (24 November 1953), p.5; Implementation of PD 810 with Respect to Borax, US MESL Item 3715, Code Q(P)-4A." JOC Document No. 118 (23 May 1955), p.1 and attachment, p.3.